

Energy Price Formation and Valuing Flexibility

June 15, 2017

Over the past several years, the Federal Energy Regulatory Commission has focused on energy market price formation in order that prices better reflect system conditions and appropriately value resources needed to meet changing system conditions throughout an operating day. Although the commission's efforts have appropriately tackled some significant and difficult policy issues,¹ a number of the energy price formation regulatory proposals have addressed very specific and, in some cases, very narrow issues.²

PJM has supported FERC's efforts but believes a fundamental price formation issue remains to be addressed – one which would have far greater implications for the future profile of the generation fleet. Specifically, PJM wishes to initiate dialogue on the following issues:

- **Pricing Reform:** Refining locational marginal price (LMP) formation to recognize the contribution of all resources, including large, inflexible units (often referred to as “baseload” resources) in serving load in a given interval
- **Impacts of Negative Offers:** Addressing the pernicious effect that negative offers may have in hastening the premature retirement of economic thermal generation, whose continuing operation is needed to meet capacity requirements and provide reliability services to accommodate for the intermittency of renewable generation

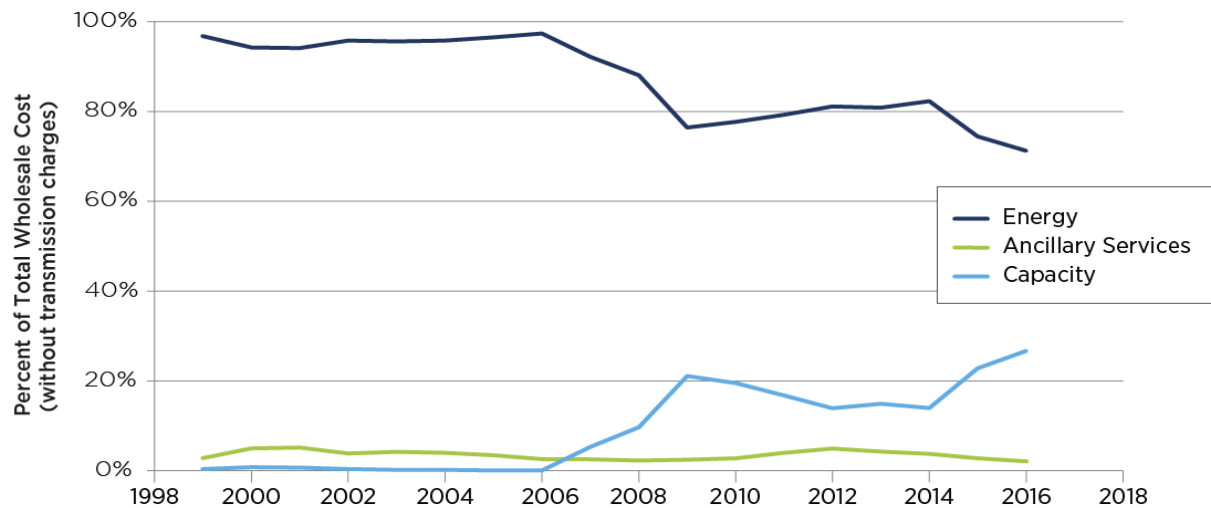
Pricing Reform: Ensuring LMP Reflects Resources Needed to Serve Load

PJM is observing diminishing energy market returns to supply resources, resulting in a shift to the capacity market for a greater proportion of units' recovery of total costs. This shift could lead to an unintended bias in the energy market, favoring lower capital cost resources. Figure 1 shows that this cost shift has been more pronounced since 2014.

¹ For example, amendments to the \$1,000 nationwide offer cap

² For example, the FERC staff has issued separate Notices of Proposed Rulemaking on extremely granular issues such as cost allocation associated with uplift (Docket No. RM 17-2-000) and a second associated with creating specific pricing rules for a limited class of resources deemed “Fast Start” resources (RM 17-3-000).

Figure 1. Share of Total Wholesale Electricity Costs



Low energy market prices, in and of themselves, are beneficial for consumers and desirable – provided they result from the fundamentals of supply and demand in the market. A concern arises, however, if prices are driven not solely by strict supply and demand fundamentals but in part by a failure of current energy pricing mechanisms to fully and transparently value all resources. Although the trend is not new, its impact on energy prices is heightened because of flattening supply curves and low demand, which put financial stress on all units – particularly large units with high capital costs.

PJM’s price formation initiatives seek to prompt discussion to consider whether the true marginal cost of serving load is recognized and transparently signaled to buyers, sellers, asset investors and financial traders in the LMP-based market clearing process. In turn, reform of this sort should reduce uplift costs and improve price signals to support efficient investment and retention decisions.

PJM Response to FERC Fast-Start Pricing Notice of Proposed Rule Making

The FERC recognized the energy market price formation issue in its recent “Fast-Start” Pricing Notice of Proposed Rulemaking (NOPR).³ PJM supports the price-setting aspects of the NOPR and believes that this initiative promises beneficial and fundamental change. However, because the FERC’s proposed scope price setting reform is limited only to “fast start” resources (principally natural gas-fired combustion turbine units), it does not extend the benefits of the proposed change to larger units (such as coal and nuclear units) to the extent they are needed to serve load in a given hour. Although the fast-start NOPR is helpful in identifying the issue of price-setting eligibility, its proposed remedy may address only a subset of the larger issue. PJM, with input from ISO/RTOs and stakeholders, believes price formation should be addressed on a broader scale and the inquiry should not be limited only to a particular class of flexible resources.

Expanding Eligibility to Set Price Beyond Flexible and Fast Start Resources

If the system needs a unit’s output to maintain power balance while managing transmission constraints, that need should be reflected transparently through energy prices. PJM believes the range of resources eligible to set price should be expanded to include *all* units whose output is needed to serve load or control transmission constraints in a given interval.

³ Docket No. RM 17-3-000 (December 15, 2016)

Presently, only additional megawatts above a unit's economic minimum are considered "needed" for economic dispatch and therefore eligible to set price.

This expansion of price-setting eligibility would include:

- Inflexible units⁴ needed to meet demand for five minute increments
- Evaluations of requirements for unit parameters such as ramp rates, economic minimums and emergency minimums

Allowing *all* units to set price would create a function in which price more consistently increases as load increases. It also would remove the current discontinuity in LMP created when a unit's output is reduced to its economic minimum level at which point the entire output of the unit is removed from price-setting eligibility. This price-setting expansion would reduce uplift and lead to better incentives and more predictable, rational price signals. This concept is illustrated with an example in Figure 2, which illustrates two options for setting LMP in a simple system with increasing load to serve and two units available for dispatch – one flexible and the other inflexible.

The flexible unit can be dispatched from 0 megawatts output up to 300 MW output. Its offer price begins at \$30 at 100 MWh of output and increases by \$0.01 for every megawatt-hour of output in excess of 100 MWh. The inflexible unit is either off-line or on-line with an output of 100 MW and has an offer price of \$40/MWh.

As load increases from 100 MW, the flexible unit's output is increased and sets LMP at a consistently increasing value consistent with its increasing output.

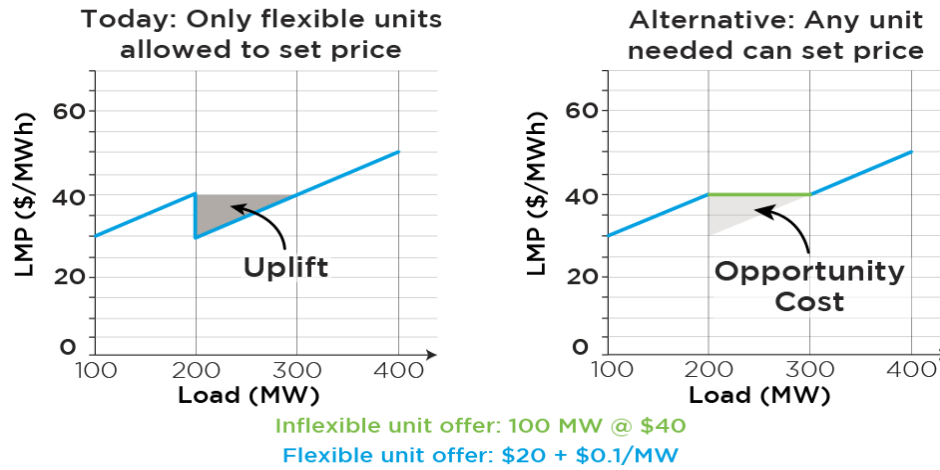
At 200 MW of load and \$40/MWh LMP, it is economic to start the 100 MW inflexible unit because dispatching additional megawatts from the flexible unit would cost \$40.01/MWh and higher. However, because the 100 MW unit must come online and produce all of its 100 MW, the flexible unit must be dispatched down by 100 MW to maintain generation and load balance.

Under today's rules, the inflexible unit would be ineligible to set LMP, and the LMP would therefore drop to \$30/MWh, the offer price of the flexible unit at its reduced dispatch level. As load continues to increase, the flexible unit once again is dispatched up, and LMP increases along with the flexible unit's increasing offer price at its increasing output value. Until the LMP reaches \$40/MWh, the inflexible unit must be made whole to its offer because it is operating with a cost in excess of the LMP.

PJM's proposal would instead allow the inflexible unit to set LMP, thereby transparently indicating the cost of the most expensive unit necessary to economically serve the load. The resultant opportunity cost experienced by the flexible unit could form the basis for a load-following product as described below.

⁴ PJM already allows demand response resources to set LMP when their reductions are necessary to maintain power balance and will continue to do so as discussion of these additional reforms moves forward.

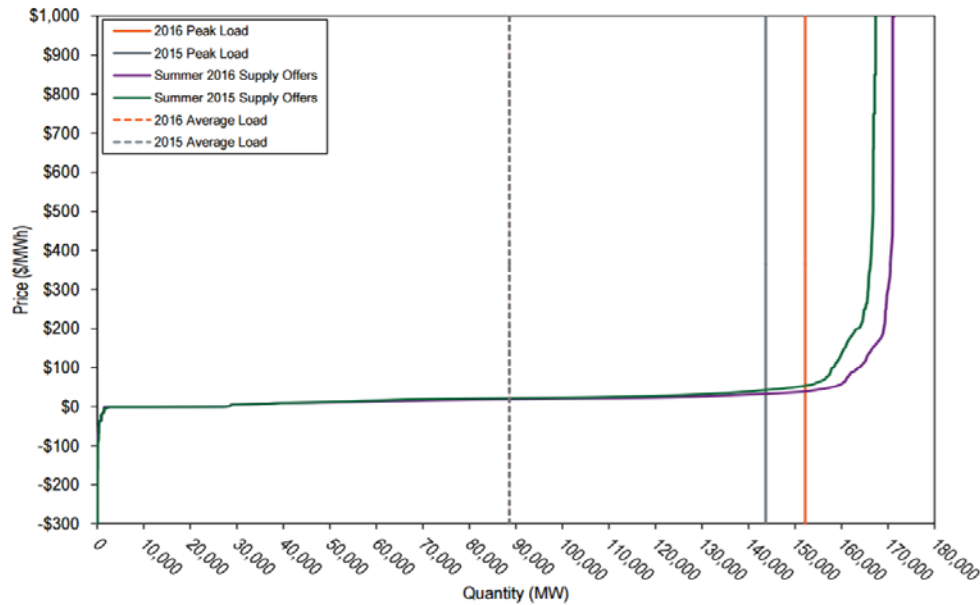
Figure 2. Comparison of Price Setting Methods



Developing a Complementary Load-following Product to Value Flexibility

Price formation has grown in importance as the supply curve in systems across the nation continues to flatten. Figure 3 displays this supply curve trend in the PJM footprint. Units formerly considered base and mid-merit now are being relied on to operate more flexibly as if they were peaking units. Many times, these same units are ineligible to set LMP based on their operating parameters. Excess supply in light of reduced load levels has also contributed to a flattening of the supply curve. As a result of these supply curve trends, incremental movements in LMP seem less effective in incenting units to reduce output to follow dispatch.

Figure 3. Average PJM Aggregate Real-Time Generation Supply Curves in summer 2015 and 2016^{5, 6}



⁵ Monitoring Analytics, LLC. *PJM State of the Market Report – 2016*. Section 3 – Energy Market

⁶ Real-time average hourly load was 88,601 MW in 2016 and 88,594 MW in 2015.

PJM also has observed that resources using natural gas as their primary fuel tend to acquire gas on an inflexible basis, given the economic advantage in so doing and the limited availability of flexible pipeline transportation products.

The limited LMP variations at the margins coupled with natural gas procurement limitations combine to reduce economic incentives for resources to follow PJM dispatch signals. This phenomenon erodes a critical mechanic in LMP pricing: its ability to create economic incentives for units to follow RTO dispatch instructions in order to ensure efficient dispatch of the system and maintain system reliability.

To maintain generation and load balance when inflexible units are dispatched, the proposed pricing eligibility reform should be accompanied by development of a load-following product, which would compensate flexible resources forced to ramp up or down uneconomically to meet demand when a larger, inflexible resource must operate at a minimum output level.

Flexibility is not explicitly valued in PJM today. Reforming pricing so that inflexibility does not negatively impact LMP would allow PJM to monetize flexibility. The load-following product thus would provide enhanced opportunities for flexible resources, including new technologies, such as energy storage resources, to receive compensation for the value of their flexibility without displacing the need for the dispatch of larger, more inflexible units in the circumstances outlined above.

Valuing flexibility in electricity markets also could potentially drive innovation with respect to flexibility in the gas nomination cycle and promote enhanced gas-electric coordination. These incentives would drive gas-fired units to acquire – and pipelines to offer – more flexible products so that natural gas units could take advantage of the economic benefits associated with offering their flexibility to the market.

Addressing Impacts of Negative Offers

PJM has observed negative energy market offers from wind generation enabled by the federal wind production tax credit (PTC). The negative offers, encouraged by this production subsidy, negatively impact all resources by distorting price signals and eroding revenue streams. The erosion of value for assets needed to maintain critical resources used to ensure reliability is of particular concern given the intermittency of renewable resources. While respecting the decisions of Congress to maintain, but phase-out the wind PTC, PJM believes a FERC initiative is necessary to address the impacts of negative offers on the wholesale markets that FERC is jurisdictionally bound to protect.

There are several ways to address the issue of negative pricing, such as expanding price-setting eligibility while implementing a flexibility product as described above. The economic challenges facing the industry as well as the operational challenges faced by units that are unwilling to curtail in response to dispatch instructions during low-load periods argue for a broader discussion on ways to ensure grid reliability in the face of negative pricing. PJM intends to raise this issue with stakeholders and regulators in order to assist in the development of national and regional solutions that address reliability needs.

Moving Forward

PJM believes that expanding price-setting eligibility to better recognize the contributions of all resources in the energy market would be a productive first step toward more efficient price formation. This effort could be coordinated with development of a load-following product or, more broadly, reforming pricing for reserves.

The ideas and initiatives described above do not comprise an exhaustive list of items that PJM would encourage the FERC and stakeholders to consider. PJM and stakeholders are considering other initiatives in parallel:

- A related reserve and resilience pricing effort, which is further detailed in PJM's Resilience Roadmap. Part of enhancing resilience involves instituting operational reforms in which PJM would commit additional reserves or operate the system more conservatively.⁷ PJM believes that reserve markets and the method by which PJM co-optimizes reserve products with energy is a significant opportunity to enhance the market price formation while making the system more resilient through efficient commitment and pricing.
- A consolidation of PJM's current three-part bid structure, consisting of startup costs, no-load costs and incremental cost, to a two-part bid using only startup costs and the incremental offer.
- A revision of the demand curve used in shortage pricing.⁸ The revision adds a smaller step to the demand curve to better reflect the lower reliability concern of small reserve deficiencies. This change potentially could create more effective price signals before synchronized reserves fall below the largest contingency requirement.

PJM is performing analysis and simulations to evaluate the concepts described above. PJM will encourage proactive action to be taken by the FERC to begin to address needed reforms in each of the above areas. This working document encapsulates PJM's preliminary thoughts, which will continue to be refined in consultation with policymakers and stakeholders.

⁷ In the recent report, "[PJM's Evolving Resource Mix and System Reliability](#)," PJM highlighted the need to focus on grid resilience, which means preparing for significant, credible system events, being able to operate through such events, and building the capability to recover quickly.

⁸ This effort is related to FERC Order No. 825 on shortage pricing reforms. PJM submitted a section 205 filing on May 12, 2017, regarding changes to the Operating Reserve Demand Curve (Docket No. ER17-1590-000).